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Management of malformation disease of mango (mangifera indica l.) Trees

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ABSTRACT: Malformation disease, caused by the fungus Fusarium mangiferae, poses a significant threat to mango (Mangifera indica L.) trees worldwide, leading to substantial yield losses and economic impact. Effective management strategies are crucial to mitigate the spread and impact of this disease. This review provides a comprehensive overview of the management practices for malformation disease of mango trees, encompassing cultural, chemical, biological, and integrated approaches. Cultural practices such as sanitation, pruning, and orchard management play a fundamental role in disease prevention and control. Chemical control measures involve the use of fungicides, although their efficacy can be limited due to the development of resistance and environmental concerns. Biological control methods utilizing antagonistic microorganisms offer promising alternatives, with biopesticides and biofungicides demonstrating efficacy in suppressing disease progression. Integrated disease management strategies, combining multiple control measures, are increasingly advocated for sustainable disease control while minimizing chemical inputs and environmental impact. Furthermore, ongoing research efforts aimed at understanding the pathogen's biology and host-pathogen interactions are essential for the development of innovative management approaches. Overall, a multifaceted and integrated approach combining cultural, chemical, and biological control methods tailored to specific agroecological conditions is crucial for effective management of malformation disease in mango trees.

Keywords: Mango, Mangifera indica L., Malformation disease, Fusarium mangiferae, Management, Cultural practices, Chemical control, biological control, Integrated disease management.

INTRODUCTION

Mango (Mangifera indica L.) is one of the most economically important fruit crops globally, valued for its delicious flavor, nutritional content, and versatility in culinary applications. However, the sustainable production of mangoes is often challenged by various biotic and abiotic factors, among which malformation disease stands out as a significant threat. Malformation disease, caused by the fungus Fusarium mangiferae, affects mango trees worldwide, leading to severe yield losses, reduced fruit quality, and economic repercussions for growers and stakeholders.

The symptoms of malformation disease are characterized by the formation of abnormal vegetative and floral structures, including swollen shoot tips, distorted leaves, and malformed inflorescences. Infected trees often exhibit stunted growth, reduced vigor, and poor fruit set, ultimately compromising the productivity and profitability of mango orchards. Moreover, the disease can spread rapidly within and between orchards, posing challenges for disease management and control.

Efficient management strategies are essential to mitigate the impact of malformation disease on mango production and ensure the sustainability of mango cultivation. Over the years, various management approaches have been developed and implemented to combat this fungal disease, encompassing cultural, chemical, biological, and integrated methods. Cultural practices, such as sanitation, pruning, and orchard management, play a pivotal role in disease prevention and control by reducing inoculum levels and creating unfavorable conditions for pathogen proliferation.

Chemical control measures involve the application of fungicides to suppress fungal growth and minimize disease spread. However, the efficacy of chemical treatments can be compromised by factors such as resistance development, environmental concerns, and potential residues in fruit. In recent years, there has been a growing emphasis on biological control methods, utilizing beneficial microorganisms to antagonize the pathogen and enhance plant resistance. Biopesticides and biofungicides offer environmentally friendly alternatives to conventional chemicals, with promising results in disease suppression.

Integrated disease management (IDM) strategies, which combine multiple control measures in a coordinated and complementary manner, have emerged as a holistic approach to sustainable disease control. By integrating cultural, chemical, and biological tactics, IDM aims to optimize disease management efficacy while minimizing environmental impact and reliance on chemical inputs.

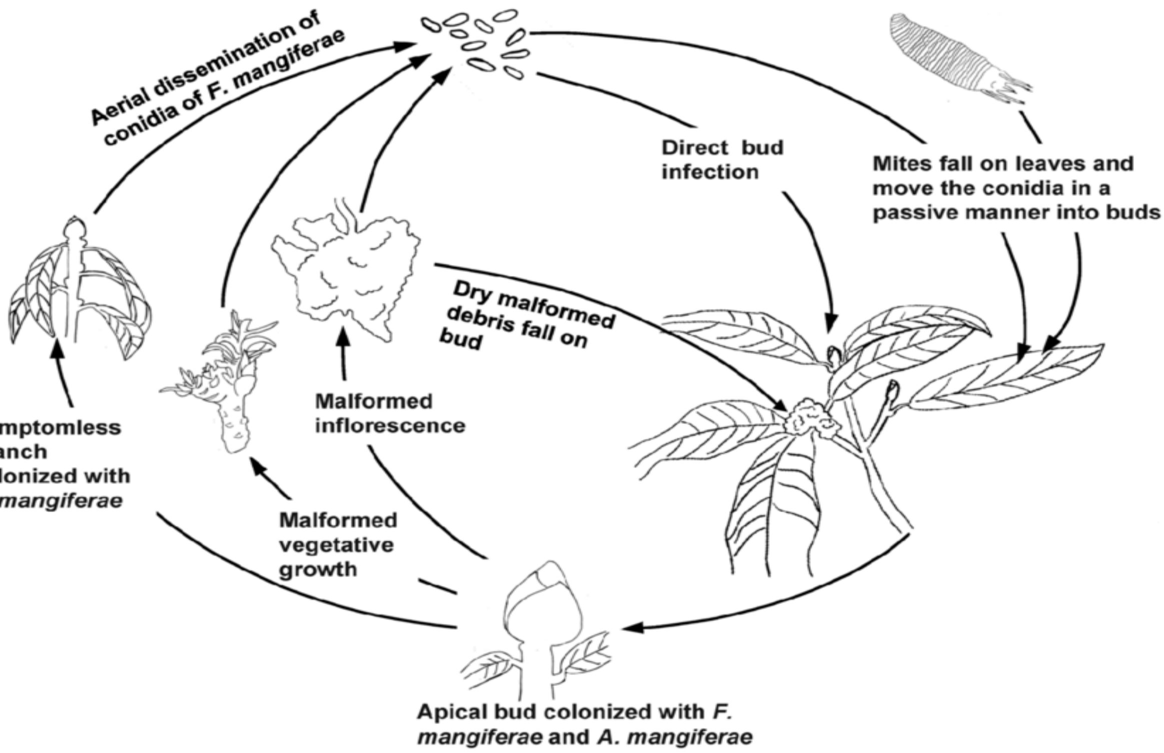

Fig-1

Despite considerable progress in understanding the biology and epidemiology of malformation disease, several challenges remain in its management, including the development of resistant mango cultivars, optimization of control strategies, and dissemination of knowledge to growers. Ongoing research efforts and collaboration between researchers, extension agents, and growers are essential for the development and adoption of effective management practices tailored to specific agroecological conditions and socio-economic contexts.

LITERATURE REVIEW

Etiology and Pathogenesis: Fusarium mangiferae, the causal agent of malformation disease, primarily infects mango trees through wounds or natural openings, such as stomata, during the flowering and vegetative growth stages. Upon infection, the fungus colonizes the vascular tissues, leading to disruption of nutrient and water transport, as well as the production of toxins that induce abnormal growth and development in infected tissues. The exact mechanisms underlying malformation symptom development are still under investigation, but recent studies have elucidated the role of fungal toxins and host-pathogen interactions in disease progression.

Epidemiology and Disease Cycle: The epidemiology of malformation disease is complex, influenced by factors such as environmental conditions, host susceptibility, and fungal inoculum levels. The disease can spread rapidly within and between orchards through infected plant materials, contaminated tools, and windborne spores. The establishment of primary and secondary infections during the flowering and vegetative growth stages contributes to the persistence and dissemination of the pathogen within mango orchards. Understanding the disease cycle and key epidemiological factors is essential for developing effective management strategies.

Cultural Management Practices: Cultural management practices play a crucial role in the prevention and control of malformation disease. Sanitation measures, including the removal and destruction of infected plant parts, pruning of affected branches, and proper orchard hygiene, help reduce inoculum levels and limit disease spread. Additionally, promoting optimal orchard management practices, such as balanced nutrition, irrigation management, and canopy management, enhances tree vigor and resilience to disease.

Chemical Control: Chemical control measures, including the application of fungicides, are commonly used to manage malformation disease in mango orchards. Various fungicides, such as azoles, strobilurins, and triazoles, have been evaluated for their efficacy in suppressing fungal growth and reducing disease incidence. However, challenges such as fungicide resistance development, environmental concerns, and potential residues in fruit highlight the need for judicious and integrated approaches to chemical control.

Biological Control: Biological control methods offer sustainable alternatives to conventional chemical fungicides for managing malformation disease. Antagonistic microorganisms, such as Trichoderma spp., Bacillus spp., and Pseudomonas spp., have been investigated for their ability to inhibit fungal growth and promote plant health. Biopesticides and biofungicides based on these beneficial microorganisms have shown promise in reducing disease severity and enhancing mango tree resistance to Fusarium mangiferae.

Integrated Disease Management (IDM): Integrated disease management (IDM) strategies, which combine cultural, chemical, and biological control measures, offer a holistic approach to managing malformation disease while minimizing environmental impact and optimizing efficacy. By integrating multiple tactics tailored to specific agroecological conditions, IDM aims to enhance disease suppression and sustainably improve mango production.

Overall, a multidisciplinary approach encompassing research, extension, and stakeholder collaboration is essential for developing and implementing effective management strategies for malformation disease of mango trees. Continued efforts in understanding the disease biology, evaluating control methods, and disseminating knowledge to growers are crucial for mitigating the impact of malformation disease and ensuring the long-term sustainability of mango production.

ETHYLENE' ORIGIN NATURE OF MALADY

The role of ethylene in mango malformation has been extensively studied by several researchers (Singh et al. 1994; Pant 2000; Bains and Pant 2003; Nailwal et al. 2006; Krishnan et al. 2009; Rymbai and Rajesh 2011; Ansari et al. 2012, 2013a, b; Rani et al. 2013; Singh et al. 2014). Malformation-like substances are believed to stimulate ethylene production, thereby contributing to the development of malformation symptoms (Singh and Dhillon 1989a). Studies have reported significantly higher levels of ethylene in malformed panicles of mango cultivar Dashehari at various developmental stages, including fully swollen buds, bud inception, full-grown panicles prior to full bloom, and at full bloom (Singh and Dhillon 1990). Similarly, shoots bearing malformed panicles have exhibited significantly elevated levels of ethylene compared to those bearing healthy panicles.

Ethylene has been identified as a key player in the causation of floral malformation in various mango cultivars, such as Amrapali, Bombay green, Chausa, Dushehri, and Mallika. Endogenous ethylene content was found to be higher in malformed tissues compared to healthy ones, particularly under low temperature conditions during stages prior to full bloom and at full bloom (Ansari et al. 2013a). Cyanide, produced in amounts stoichiometrically equivalent to ethylene, is detoxified by conversion to β-cyanoalanine by β-Cyanoalanine synthase (β-CAS), an enzyme primarily responsible for cyanide detoxification in plants. Lower levels of β-CAS were observed in malformed tissues compared to healthy tissues, indicating a greater accumulation of unmetabolized hydrogen cyanide (HCN) in healthy tissues (Kukreja and Pant 2000). Consequently, the death of malformed mango tissues may be attributed to necrosis resulting from excessive cyanide production along with 'stress ethylene' (Ansari et al. 2013a).

Moreover, unmetabolized cyanide has been detected in malformed tissues, with concentrations peaking during the period of maximum photosynthesis in the plant (Nailwal et al. 2006). These findings suggest a potential circadian rhythm of cyanide and ethylene production, highlighting the influence of daily light and temperature variations on the appearance of malformation symptoms in mango tissues. Understanding the intricate interplay between ethylene, cyanide production, and environmental factors is crucial for elucidating the mechanisms underlying mango malformation and developing effective management strategies for this debilitating disease.

SYMPTOMS OF MALADY BEAR A RESEMBLANCE TO ETHYLENE EFFECTS

The functional characteristics of mango malformation, including altered morphology of panicles and shoots, increased radial growth of rachis, and reduced length and broadening of secondary branches, have been linked to elevated levels of ethylene (Ansari et al. 2013a). Enlarged lenticels, known as hypertrophy, leaf epinasty, and disturbances in the natural growth patterns of shoots and inflorescences in malformed trees, are also attributed to the effects of ethylene (Rymbai and Rajesh 2011). Additionally, ethylene is implicated in the termination of apical dominance, leading to increased radial growth of rachis in malformed inflorescences (Singh and Dhillon 1989b).

Moreover, in malformed mango panicles, fused lobed anthers accompanied by impaired pollen grains and hooked stigma with poor stigmatic receptivity hinder the germination of pollen and subsequent growth of pollen tubes. The aberrant morphology of reproductive organs in mango inflorescences is attributed to elevated levels of endogenous ethylene, leading to malfunctions in fruit development. Furthermore, the accumulation of cyanide resulting from ethylene biosynthesis contributes to necrosis, leading to dehydration of anthers and pistils during the oversensitive reaction of plants (Rani et al. 2013).

Recent studies have confirmed the potential role of ethylene in mango floral malformation by elucidating its cross-talk with purescine, which could mitigate the negative effects of ethylene and potentially reduce malformation in mango flowers (Singh et al. 2014). It is worth noting that ethylene formation can be elicited under various abiotic and biotic stresses, further emphasizing its role in the development of mango malformation. Understanding the intricate mechanisms underlying ethylene's involvement in mango malformation is essential for developing targeted management strategies to mitigate the impact of this devastating disease on mango production.

STRESS STIMULATED ETHYLENE FORMATION

Over the past three decades, numerous studies have underscored the induction of ethylene production in response to various environmental stresses, as evidenced in both mango malformation and other systems (Ansari et al. 2013a; Jouyban 2012). A plethora of putative etiological agents contributing to mango malformation, summarized as abiotic and biotic stressors, have been identified.

Low oxygen (hypoxia) conditions, characteristic of flooded soils, have been shown to trigger ethylene accumulation in mango trees, resulting in lenticel hypertrophy (Larson et al. 1993). Furthermore, viral infections have been found to stimulate ethylene production in plants (Abeles et al. 1992). In response to insect infestation, most plants release ethylene, with oral oozing-specific compounds from insects serving as elicitors of ethylene production (Dahl and Baldwin 2007).

Chemical stimuli such as metal ions, herbicides, and gases like sulfur dioxide (SO2) have also been demonstrated to significantly promote ethylene release (Rymbai and Rajesh 2011; Ievinsh 2012). Additionally, certain species of Fusarium fungi are capable of producing ethylene themselves (Swart and Kamerbeek 2010). Recently, the role of Fusarium mangiferae in contributing to the endogenous "stress ethylene pool" in mango plants has been recognized (Ansari et al. 2013a, b).

Establishing a circadian rhythm of cyanide and ethylene production during the period from 11:00 a.m. to 1:00 p.m., Nailwal et al. (2006) highlighted the correlation between daily light and temperature variations and ethylene production. These findings underscore the complex interplay between ethylene production and various environmental stressors, shedding light on the mechanisms underlying mango malformation and other stress-induced physiological responses in plants.

CONCLUSION

However, through extensive research and the implementation of various management strategies, progress has been made towards mitigating the impact of this devastating disease.

The role of ethylene in mango malformation has been extensively studied, with elevated levels of ethylene implicated in the development of malformation symptoms. Additionally, various abiotic and biotic stressors, such as hypoxia, viral infections, insect infestations, and chemical stimuli, have been shown to trigger ethylene production, further exacerbating malformation in mango trees.

Effective management of malformation disease requires a multi-faceted approach, encompassing cultural, chemical, biological, and integrated strategies. Cultural practices, including sanitation, pruning, and orchard management, play a crucial role in disease prevention and control. Chemical control measures, such as fungicide applications, can help suppress fungal growth, while biological control methods utilizing antagonistic microorganisms offer environmentally friendly alternatives.

Integrated disease management (IDM) strategies, which combine multiple control measures, have emerged as holistic approaches to sustainable disease control. By integrating cultural, chemical, and biological tactics, IDM aims to optimize disease management efficacy while minimizing environmental impact and reliance on chemical inputs.

Furthermore, ongoing research efforts aimed at elucidating the underlying mechanisms of mango malformation and developing innovative management strategies are essential for the long-term sustainability of mango production.

In summary, the effective management of malformation disease in mango trees requires a comprehensive and coordinated approach, leveraging our understanding of ethylene production, environmental stressors, and the complex interactions between the pathogen, host, and environment.

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